INTRODUCTION

This module provides information about identifying packagings used to transport radioactive material and how to recognize this material when responding to a transportation incident.

Four types of packages will be discussed; Excepted packaging, Industrial packaging, Type A packaging and Type B packaging. Consideration for the mode of transporting radioactive material will be discussed. You will learn the philosophy behind radioactive material packaging design as well as the safety features associated with the radioactive material package and the stringent package testing requirements.

PURPOSE

The purpose of this module is to provide you with a basic understanding of the types of packages used to transport radioactive material and the potential hazard posed by the material contained within these packages. This information will help increase your knowledge of appropriate responses to a radiological transportation incident.

MODULE OBJECTIVES

Upon completion of this module, you will be able to:

1. Identify typical packages used in the transport of radioactive material.
2. List examples of radioactive material that are shipped in various shipping packages.
3. Identify the risks associated with the various shipping packages.
4. Identify the testing methods for Type A and B Packages.

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TRANSPORTING RADIOACTIVE MATERIAL

Radioactive material has many uses that affect us every day. Radioisotopes save lives, power pacemakers, and help doctors diagnose and treat illnesses. They also make our lives safer. One kind of radioisotope is used in a smoke detector and another detects explosives in airport luggage. Radioisotopes are also used in manufacturing everyday products like plastic wrap, radial tires, and coffee filters.

For a radioactive material to be useful, it must be shipped where it is needed. Shipments of radioactive material are carefully regulated to maximize safety to the public and environment. As a major shipper of radioactive material, the Department of Energy (DOE) complies with all applicable regulations.

In the United States, more than two-thirds of radioactive material shipments are of man-made radioisotopes used in medicine, industry, agriculture, and scientific research. After production in laboratories, radioisotopes are delivered to hospitals, factories, and research laboratories where they are used in processes that often produce small quantities of low-level waste. The waste must then be shipped for disposal. Low-level waste includes items like contaminated gloves, booties, and other protective clothing.

Radioactive materials have been used in the defense of our nation and have left waste that needs to be cleaned up and disposed of safely. Environmental cleanup at both present and former DOE sites results in the shipment of radioactive material to storage and disposal sites.

Radioisotopes are shipped in their most stable forms. Typically, that means they are shipped as solids. When radioactive liquids or gases are transported, federal regulations require additional precautions. Careful research and design goes into packaging radioactive materials. Emergency planning, driver training, and strict government inspections are a part of a program that has **never** resulted in a radiologically related death or injury from a transportation incident.

HAZARD EVALUATION

Federal regulations place strict administrative controls on the transport of radioactive material. The worldwide philosophy of radioactive material transport is that:

- **Safety should be primarily focused on the package**. Packaging is the first line of defense.
- **Package integrity should be directly related to the degree of hazard of the material it contains.**

This two-part philosophy means that small quantities of radioactive material—quantities that would present little hazard if released—may be shipped in less secure packages.

RADIOACTIVE MATERIAL PACKAGING

Radioactive material, like other commodities, is transported every day by highway, rail, air, and water. Radioactive material is packaged to ensure that radiation levels at the package surface do not exceed federal regulations. This ensures that shippers, the public, and the environment are not exposed to radiation levels that exceed recognized safe limits.

After radioactive material is properly packaged, it is sealed, surveyed for external radiation, and checked for external contamination. The package is then marked and labeled to provide information about its contents.

Different shipping packagings are required for various types, forms, quantities, and levels of radioactivity. We will discuss four packaging types:

- Excepted Packaging
- Industrial Packaging
- Type A Packaging
- Type B Packaging

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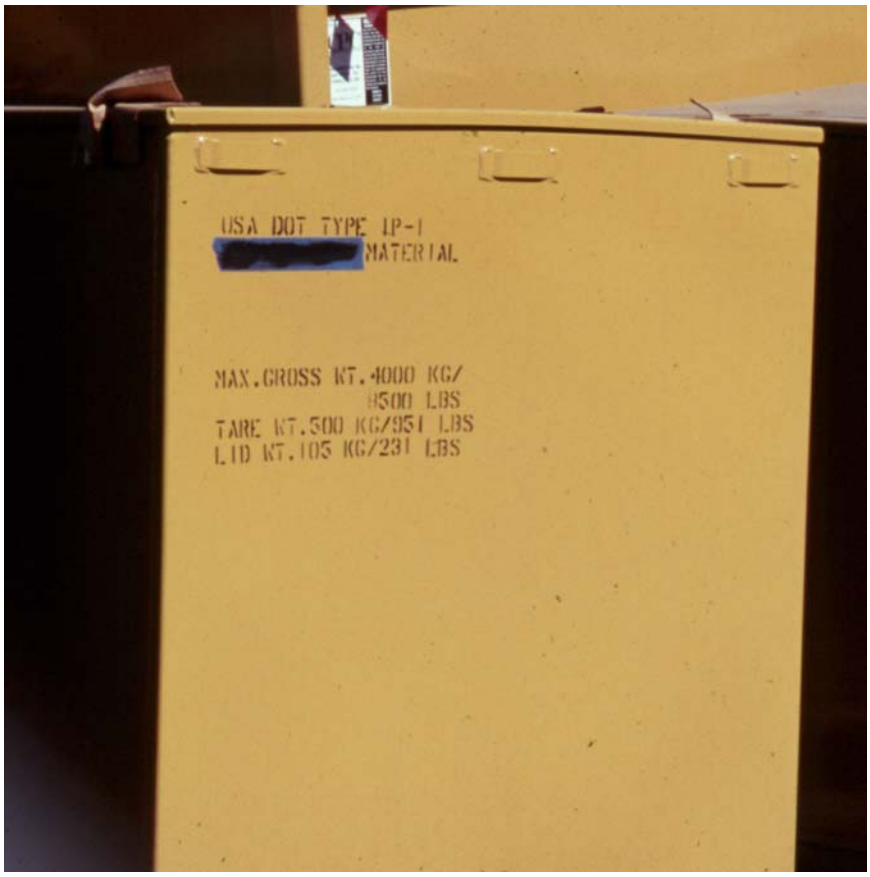
Excepted Packaging is used to transport material with extremely low levels of radioactivity. Excepted packagings are authorized for limited quantities of radioactive material that would pose a very low hazard if released in an accident. Examples of material typically shipped in excepted packaging include consumer goods like smoke detectors and lantern mantles. Excepted packagings are excepted (excluded) from specific packaging, marking, labeling, and shipping paper requirements.

Industrial Packaging is used in certain shipments of low activity material and contaminated objects, which are usually categorized as radioactive waste. Most low-level waste is shipped in these packages. Department of Transportation (DOT) regulations require that these packages allow no identifiable release of the material to the environment during normal transportation and handling. There are three categories of industrial packages: IP-I, IP-II, and IP-III. Requirements for industrial packaging are addressed in 49 CFR 173.411.



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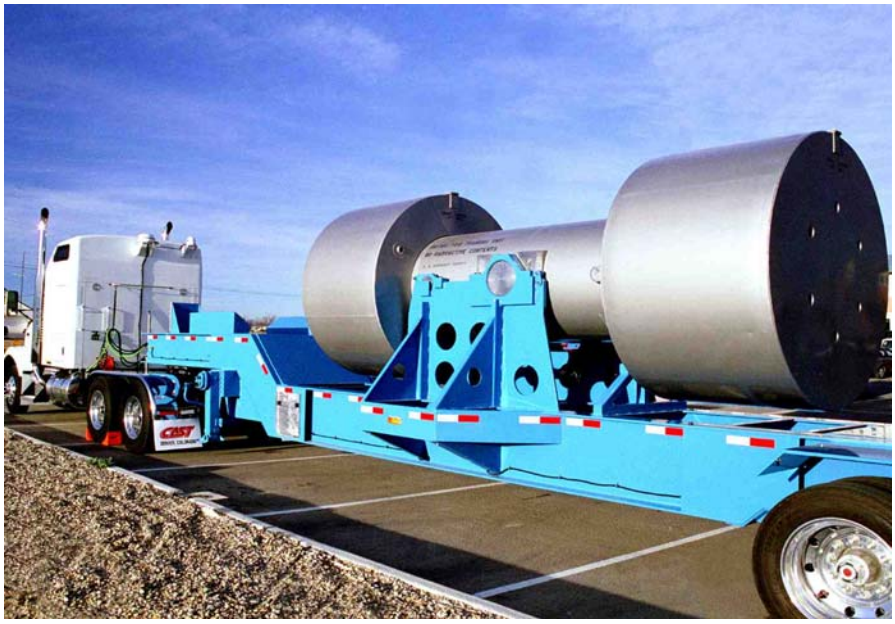
Type A Packaging is used to transport small quantities of radioactive material with higher concentrations of radioactivity than those shipped in industrial packagings. They are typically constructed of steel, wood, or fiberboard, and have an inner containment vessel made of glass, plastic, or metal surrounded with packing material made of polyethylene, rubber, or vermiculite. Examples of material typically shipped in Type A Packages include nuclear medicines (radiopharmaceuticals), radioactive waste, and radioactive sources used in industrial applications. Type A packaging and its radioactive contents must meet standard testing requirements designed to ensure that the package retains its containment integrity and shielding under normal transport conditions. Type A packaging requirements are addressed in 49 CFR 173.412.

Type A Packages must withstand moderate degrees of heat, cold, reduced air pressure, vibration, impact, water spray, drop, penetration, and compression tests. Type A Packages are not, however, designed to withstand the forces of an accident. The consequences of a release of the material in one of these packages would not be significant since the quantity of material in this package is so limited. Type A packagings are only used to transport non life-

Type B Packaging is designed to transport material with the highest levels of radioactivity. Type B packagings range from small hand-held radiography cameras to heavily shielded steel casks that weigh up to 125 tons. Examples of material transported in Type B packagings include spent nuclear fuel, high-level radioactive waste, and high concentrations of other radioactive material such as cesium and cobalt. These package designs must withstand all Type A tests, and a series of tests which simulate severe or "worst-case" accident conditions. Accident conditions are simulated by performance testing and engineering analysis. Type B Packages may contain potentially life-endangering amounts of radioactive material. Packaging requirements for Type B packaging are addressed in 49 CFR 173.413 and 10 CFR 71.



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To demonstrate that Type B Packages can withstand a severe accident, a tractor-trailer (*right*) carrying a Type B Package prototype was crashed into a massive concrete wall at 81 miles per hour. The package was slightly dented, but it did not release its simulated radioactive material.

Many radiography cameras, like the one pictured (*above*), are Type B Packages. They are heavily shielded and contain a small high-level radiation source like the one shown *(right)*.

MODES OF TRANSPORT FOR RADIOACTIVE MATERIAL

In some cases, the mode of transportation for radioactive material determines the type of packaging used. In other cases, packing determines the mode. Weight limits, degree of hazard, available routes, and regulatory requirements all affect transportation mode decisions.

Air Transport

Transportation of radioactive material by air is very tightly regulated. The pilot of the aircraft must sign a manifest acknowledging the presence of the material on the plane. Radioactive material on aircraft must be in packagings that are able to withstand the conditions of air transport, such as pressure changes, and must be stored in designated locations.

Rail Transport

Rail transportation is used for all types of radioactive material shipments. The most significant difference between rail and truck is the size of the package. Trains can carry the largest and heaviest of the Type B Packages—those that are too large for trucks. In addition, trains are often used to carry large volumes of low-level radioactive waste.

Truck Transport

Most shipments of radioactive material are made by truck. Packages used in truck transport include all of those described previously. Some high activity level shipments must be shipped over specific routes to provide maximum safety and security.

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Water Transport

Transport of radioactive material by water exists in two broad classifications: ocean and river. Ocean transport of radioactive material includes both low-level radioactive ores and high-level items such as used reactor cores. Vessels carrying radioactive material into the United States must obey very stringent Coast Guard regulations regarding entry into U.S. waters. River vessels carry material similar to that shipped by truck or train. Access to suitable port facilities, and the resulting need to transfer the material from barge to truck or train, limits the transport of radioactive material by water.

RISKS ASSOCIATED WITH RADIOACTIVE MATERIAL SHIPPING PACKAGES

Unlike some hazard transportation classes, radioactive material in transport has additional information about potential risk(s) to the responder. Some of this information can be obtained by first identifying the packaging type for the material being shipped. Excepted, Industrial, and Type A Packages contain non life-endangering amounts of radioactive material and present minimal risk if released in an accident. Type B Packages, however, may contain potentially life-endangering amounts of radioactive material that could pose significant risk if released during an accident.

The philosophy behind radioactive material transportation—where safety is primarily focused on packaging and package integrity being appropriate to the material hazard—dictates that Type B Packages be designed to withstand severe accident conditions. In the 50-year history of transporting radioactive material, there has never been a release from a certified Type B Package. In addition, there has never been an injury or death resulting from the release of radioactive material in a transportation incident.

RADIOACTIVE MATERIAL PACKAGE TESTING

Two federal agencies regulate the testing of radioactive material package designs for use in the United States: the U.S. Department of Transportation (DOT) and the U.S. Nuclear Regulatory Commission (NRC). DOT and NRC regulations are based on international regulations issued by the International Atomic Energy Agency (IAEA).

The DOT is responsible for specifying required test conditions for packages. The NRC certifies that packages designed for material with higher levels of radioactivity (i.e., Type B Packages), such as spent fuel, meet DOT test requirements. Package designs are tested using computer simulation, scale model testing, and full-scale model testing.

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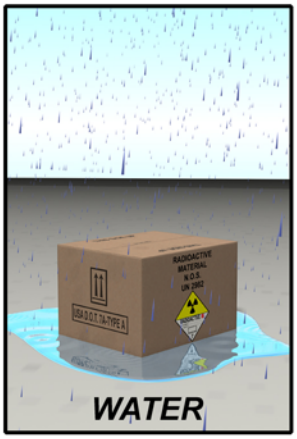
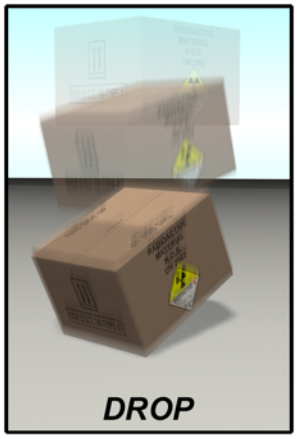
PACKAGE TESTING REQUIREMENTS

Type A Tests

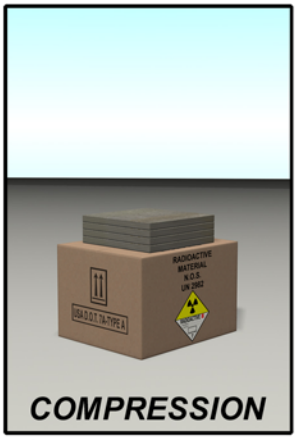
Type A Packages must be able to withstand a series of tests that simulate normal transport conditions. These tests are conducted sequentially and include:



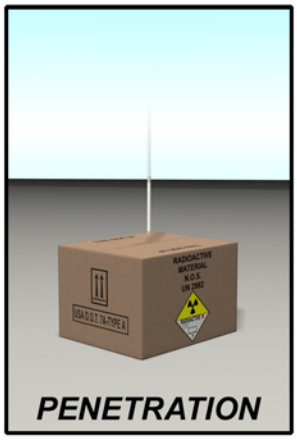
Water spray for 1 hour to simulate rainfall of 2 inches per hour.



Free-drop test onto a flat, hard surface. This test is conducted only on packages weighing 11,000 pounds or less.



Compression test of at least 5 times the weight of the package. This test is conducted for at least 24 hours.

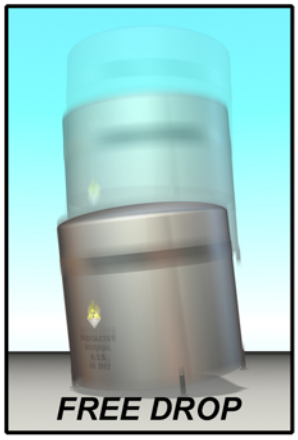


Penetration test by dropping a 13-pound, 1.25-inch diameter bar vertically onto the package from a height of 3.3 feet.

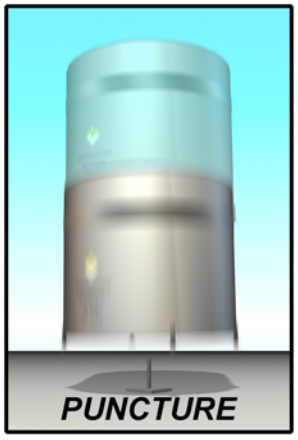
PACKAGE TESTING REQUIREMENTS

Type B Tests

In addition to the requirements for Type A Packages, the Nuclear Regulatory Commission (NRC) requires that Type B Packages be able to withstand a series of tests that simulate severe accident conditions. These tests are conducted sequentially and include:

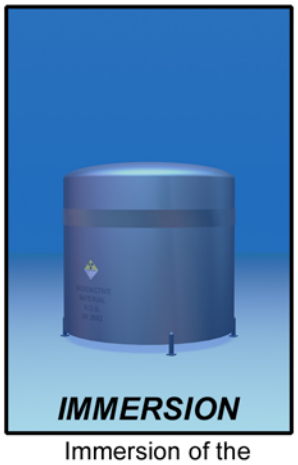


A 30-foot free drop onto a flat, un-yielding surface so that the package's weakest point is struck



A 40-inch free drop onto a 6-inch diameter steel rod at least 8 inches long, striking the package at it's most vulnerable spot.

Exposure of the entire package to 1475º for 30 minutes.



Immersion of the package under 50 feet of water for at least 8 hours.

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Check Your Understanding

1. This type of packaging, along with its radioactive contents, must meet standard testing requirements designed to ensure that the package retains its containment integrity and shielding under normal transport conditions.
   a) Type A packaging
   b) Type B packaging
   c) Industrial packaging
   d) Excepted packaging

2. _____ __ packaging must be able to withstand a series of tests which simulate severe or "worse case" accident conditions.

3. Radiopharmaceuticals are typically shipped in _____ __ packagings and spent nuclear fuel is typically shipped in _____ __ packagings.

4. Which of the following statements best applies to the risks associated with material shipped in Type A Packages?
   a) Type A Packages are used to transport very high levels of radioactive material.
   b) Type A Packages are used to transport exempt quantities of radioactive material.
   c) Type A Packages are built to withstand the most severe accident conditions.
   d) Type A Packages contain non life-endangering amounts of radioactive material.

ANSWERS

1. a
2. Type B
3. Type A
   Type B
4. d

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